Table C.4-3. (Continued).

ALPHA LEVEL=.05 DF=16 MS=0.15453

GROUPING				MEAN	N	X	Y	PL
		A		9.506693	2	3	1	1
		A						
B		A		9.197696	2	3	1	2
B		A						
B		A		9.136005	2	3	3	3
B		A						
B		A	C	8.945569	2	3	1	3
B		A	C					
B		A	C	8.938900	2	2	3	2
B		A	C					
B		A	C	8.823149	2	3	3	1
B		A	C					
B		A	C	8.696555	2	2	1	2
B			C					
B			C	8.558884	2	2	1	2
B			C					
B		D	C	8.433929	2	2	3	1
B		D	C					
B		D	C	8.350513	2	2	3	3
B		D	C					
B	E	D	C	8.274857	2	3	3	4
	E	D	C					
	E	D	C	8.189485	2	2	3	4
	E	D	C					
	E	D	C	8.101488	2	2	1	4
	E	D	C					
	E	D	C	8.056898	2	3	1	4
	E	D						
	E	D		7.551899	2	3	3	1
	E							
	E			7.351759	2	2	1	1

Table C.4-4. Statistical analysis for total macroinvertebrate biomass from artificial substrates, R.P. Smith station, 1979 (X = Transect, Y = Bank, PL = Time).

DEPENDENT VARIABLE: TOT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	15	17.38467782	1.15897852	1.42	0.2485	0.570427	19.8532
ERROR	16	13.09194798	0.81824675		STD DEV		TOT MEAN
CORRECTED TOTAL	31	30.47662580			0.90456992		4.55630102

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
X	1	0.01091667	0.01	0.9095	1	0.01091667	0.01	0.9095
Y	1	0.12475305	0.15	0.7013	1	0.12475305	0.15	0.7013
PL	3	3.07395175	1.25	0.3240	3	3.07395175	1.25	0.3240
X*Y	1	0.60186797	0.74	0.4038	1	0.60186797	0.74	0.4038
X*PL	3	6.85439551	2.79	0.0740	3	6.85439551	2.79	0.0740
Y*PL	3	3.66206866	1.49	0.2546	3	3.66206866	1.49	0.2546
X*Y*PL	3	3.05672421	1.25	0.3263	3	3.05672421	1.25	0.3263

Table C.4-5. Community comparisons of left and right banks at Transect 3 for artificial substrate data using Kendall's coefficient of concordance.

OBS	TAXA	LEFT	RIGHT	L_RANK	R_RANK
1	HYDRA (LPIL)	43.01	0.00	32.0	11.0
2	TURBELLARIA-(LPIL)	0.00	43.01	9.5	34.5
3	NEMERTINA (LPIL)	1677.42	3526.88	75.0	77.0
4	NEMATODA (LPIL)	43.01	924.73	32.0	67.0
5	MANAYUNKIA SPECIOSA	21.51	688.17	21.5	68.0
6	CHAETOGASTER (LPIL)	43.01	0.00	32.0	11.0
7	NAIS (LPIL)	1655.91	236.56	74.0	55.5
8	PRISTINA (LPIL)	580.65	3010.75	67.5	76.0
9	SLAVINA APPENDICULATA	2817.20	43.01	78.0	34.5
10	NAIDIDAE (LPIL)	387.10	236.56	61.5	55.5
11	TUBIFICIDAE (LPIL)	43.01	43.01	32.0	34.5
12	ENCHYTRAEIDAE (LPIL)	64.52	64.52	41.5	43.0
13	LUMBRICULIDAE (LPIL)	21.51	0.00	21.5	11.0
14	AEOLOSOMATIDAE (LPIL)	129.03	4086.02	53.0	78.0
15	FERRISSIA (LPIL)	43.01	0.00	32.0	11.0
16	HYDRACARINA (LPIL)	0.00	43.01	9.5	34.5
17	OSTRACODA (LPIL)	43.01	0.00	32.0	11.0
18	CYCLOPOIDA (LPIL)	172.04	0.00	56.5	11.0
19	HARPACTICOIDA (LPIL)	86.02	258.06	44.0	57.0
20	GAMMARUS (LPIL)	64.52	43.01	41.5	34.5
21	GAMMARIDAE (LPIL)	0.00	43.01	9.5	34.5
22	AMPHIPODA (LPIL)	0.00	43.01	9.5	34.5
23	ISONYCHIA (LPIL)	43.01	86.02	32.0	47.0
24	STENONEMA (LPIL)	494.62	344.09	66.0	59.0
25	HEPTAGENIIDAE (LPIL)	451.61	387.10	64.0	60.0
26	EPHEMERELLA (LPIL)	0.00	559.14	9.5	64.0
27	TRICORYTHODES (LPIL)	64.52	86.02	41.5	47.0
28	CAENIS (LPIL)	473.12	43.01	65.0	34.5
29	POTAMANTHUS (LPIL)	0.00	43.01	9.5	34.5
30	EPHEMEROPTERA (LPIL)	258.06	666.67	58.5	67.0
31	GOMPHIDAE (LPIL)	43.01	0.00	32.0	11.0
32	NEHALENNIA (LPIL)	86.02	0.00	47.0	11.0
33	COENAGRIONIDAE (LPIL)	172.04	86.02	56.5	47.0
34	TAENIOPTERYX (LPIL)	430.11	602.15	63.0	65.0
35	TAENIOPTERYGIDAE (LPIL)	0.00	21.51	9.5	24.5
36	CHLOROPERLIDAE (LPIL)	0.00	43.01	9.5	34.5
37	PLECOPTERA (LPIL)	0.00	150.54	9.5	52.0
38	BEROSUS (LPIL)	0.00	107.53	9.5	50.0
39	LAMPYRIDAE (LPIL)	0.00	21.51	9.5	24.5
40	STENELMIS (LPIL)	860.21	2172.04	71.0	75.0
41	DUBIRAPHIA (LPIL)	258.06	1053.76	58.5	72.0
42	MACRONYCHUS (LPIL)	1096.77	946.24	72.0	70.0
43	ANCYRONYX (LPIL)	43.01	0.00	32.0	11.0
44	OPTIOSERVUS (LPIL)	0.00	193.55	9.5	53.0
45	ELMIDAE (LPIL)	322.58	451.61	60.0	61.0
46	COLEOPTERA POLYPHAGA (LPIL)	86.02	0.00	47.0	11.0
47	CORYDALUS (LPIL)	86.02	43.01	47.0	34.5
48	CHIMARRA (LPIL)	64.52	0.00	41.5	11.0
49	HYDROPSYCHE (LPIL)	752.69	193.55	69.0	54.0
50	CHEUMATOPSYCHE (LPIL)	2064.52	1075.27	77.0	73.0
51	POTAMYIA FLAVA	86.02	0.00	47.0	11.0
52	POTAMYIA (LPIL)	43.01	0.00	32.0	11.0
53	MACRONEMA (LPIL)	580.65	43.01	67.5	34.5
54	HYDROPSYCHIDAE (LPIL)	1892.47	473.12	76.0	62.0
55	HYDROPTILA (LPIL)	43.01	0.00	32.0	11.0
56	LEUCOTRICHIA (LPIL)	0.00	43.01	9.5	34.5
57	HYDROPTILIDAE (LPIL)	21.51	0.00	21.5	11.0
58	OECETIS (LPIL)	107.53	43.01	50.5	34.5
59	LEPTOCERIDAE (LPIL)	21.51	0.00	21.5	11.0
60	CYRNELLUS (LPIL)	129.03	0.00	53.0	11.0
61	NEURECLIPSIS (LPIL)	387.10	0.00	61.5	11.0
62	TRICHOPTERA (LPIL)	43.01	129.03	32.0	51.0
63	PARARGYRACTIS	0.00	43.01	9.5	34.5
64	CERATOPOGONIDAE (LPIL)	43.01	21.51	32.0	24.5
65	CRICOTOPUS (LPIL)	0.00	516.13	9.5	63.0
66	TANYTARSUS (LPIL)	1333.33	980.64	73.0	71.0
67	POLYPEDILUM (LPIL)	129.03	623.66	53.0	66.0
68	ABLABESMYIA (LPIL)	86.02	86.02	47.0	44.5
69	MICROTENDIPES (LPIL)	43.01	0.00	32.0	11.0
70	GLYPTOTENDIPES (LPIL)	21.51	0.00	21.5	11.0
71	EUKIEFFERIELLA (LPIL)	107.53	86.02	50.5	44.5
72	PSECTROCLADIUS (LPIL)	172.04	107.53	55.0	49.0
73	MICROPSECTRA (LPIL)	0.00	21.51	9.5	24.5
74	CHIRONOMIDAE (LPIL)	21.51	1333.33	21.5	74.0
75	SIMULIUM (LPIL)	0.00	43.01	9.5	34.5
76	EMPIDIDAE (LPIL)	817.20	301.08	70.0	58.0
77	DIPTERA (LPIL)	43.01	0.00	32.0	11.0
78	ECTOPROCTA (LPIL)	0.00	16.13	9.5	22.0

OBS	GROUP	W	F	DF1	DF2	PROB
1	1	0.691951	2.24624	76	76	0.000265128

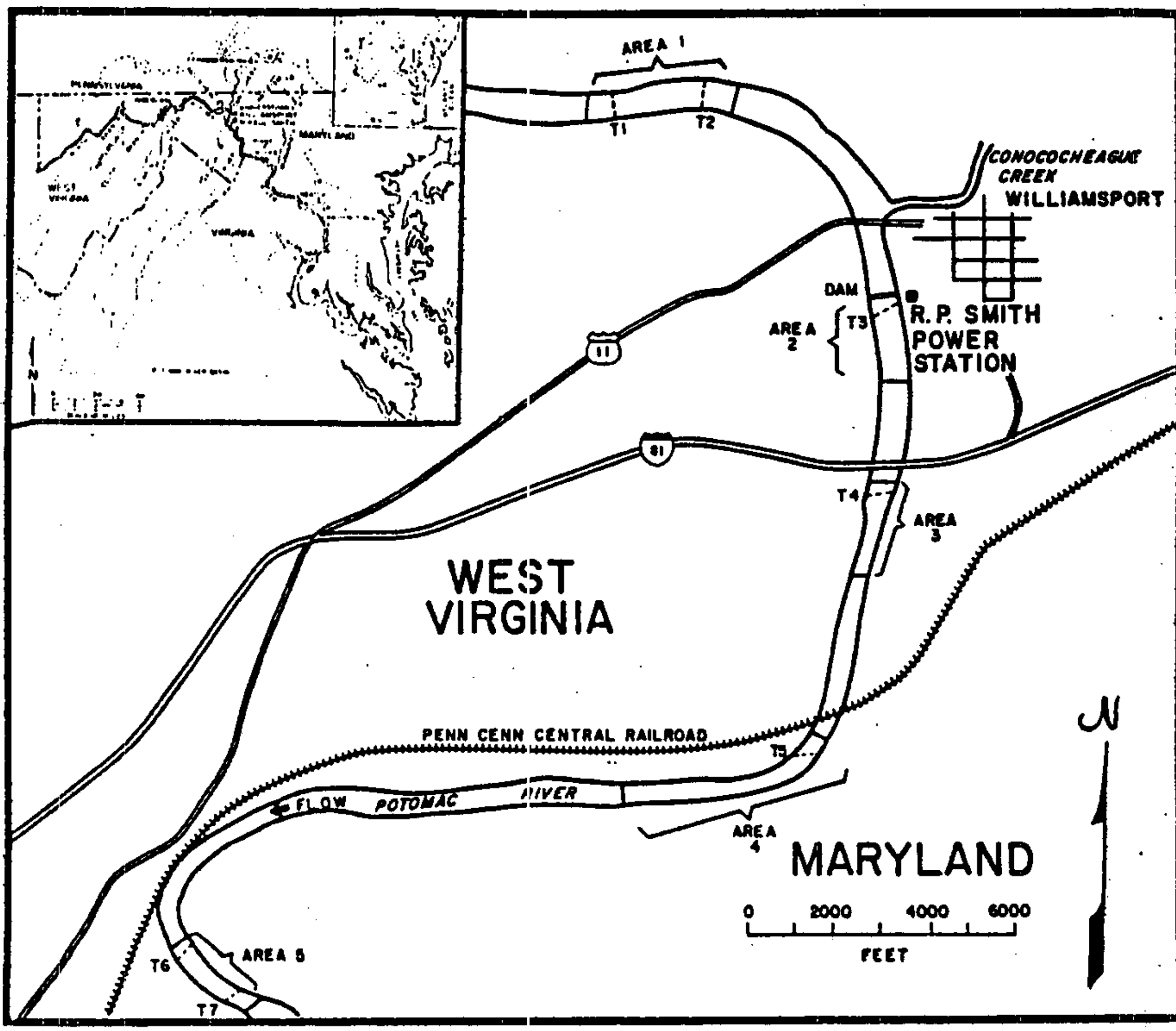

Figure C.4-1. Locations of sampling areas and transects for biological sampling in the vicinity of R.P. Smith power station.

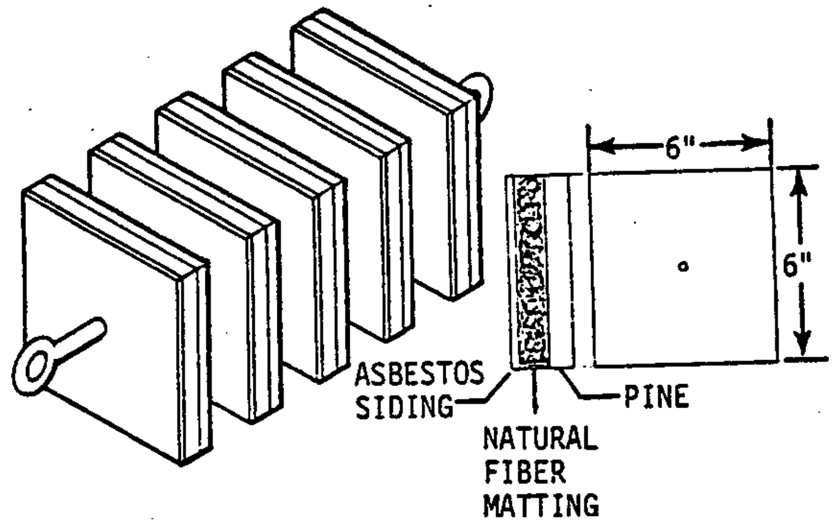

Figure C.4-2. Multiple-substrate settling-plate sampler.

APPENDIX C.5 NEARFIELD MACROBENTHOS STUDY - NATURAL SUBSTRATES (TI)

C.5-1. Objective

To determine the effects of the R.P. Smith thermal discharge on the macroinvertebrate community in the Potomac River near the power station.

C.5-2. Data Sources

Refs. 2 through 4.

C.5-3. Study History

Data were collected in three separate field studies - summer/fall 1979 (August-November); spring 1980 (May); and summer/fall 1980 (September, October). Study methodology remained similar throughout, but transect location was altered somewhat based on the results of the initial studies.

C.5-4. Sampling Methods

- For the summer/fall 1979 study, five sampling transects (T2 - T6, Fig. C.5-1) were established with three transects within the influence of the discharge plume [discharge (T3), nearfield (T4), and farfield (T5)] and two control transects [upstream (T2) and downstream (T6)]. In all subsequent studies, Transect 2 was no longer used and Transect 4 was moved upstream approximately 1,000 feet (Fig. C.5-2). Transect 1 was used in the spring 1980 study and discontinued in the summer/fall 1980 study. In all cases, two sampling stations were established at opposite sides of each transect for comparative purposes. The Maryland shore is considered the right shore or bank; the West Virginia shore, the left shore or bank.

- Two replicate samples were collected on each field collection date (i.e., August, September, October, November, 1979; May, 1980; and August, September, 1981) at all stations using a self-contained, 0.17-m^2 diver-operated dome suction sampler similar to that described in Ref. 11. After the sampler was in place, the substrate was vacuumed for 5 minutes into a 333-μ-mesh net bag; larger pebbles and rocks were placed in a rock bag and subsequently added to the net bag.

- All samples were preserved in 10% formalin.
- In the summer/fall 1980 study, the substrate at each station was sampled for particle size determinations.
- Sample depth, current velocity, air temperature, water temperature, and dissolved oxygen concentration were measured concurrently at each station on each field collection date.
- Target species were chosen for further statistical evaluation based on local abundance, potential importance to aquatic food chains, and representativeness of major invertebrate taxa (Table C.5-1).

C.5-5. Analysis

- Benthic invertebrates were identified to the lowest taxonomic level (usually genus) and enumerated for each station. Total (summer/fall 1979 only) and species-specific densities and biomasses were determined for each sampling period at each station.
- CCNAOVA (cross-classified nested analysis of variance) was used on the summer/fall 1979 data to detect significant differences in sample density and biomass among stations, banks, and months for total and target species (Tables C.5-2, C.5-3).
- A one-way ANOVA model with fixed effects was used on spring 1980 and summer/fall 1980 study data to examine significant date-specific differences in target species density and biomass among stations (Table C.5-4).
- ANCOVA (analysis of covariance) applied to the summer/fall 1980 data to examine potential differences among station densities used substrate particle size (arc sine of square root of the percentage of particles > 4 mm) as a covariate.
- Kendall's coefficient of concordance was used to examine transect and bank effects on community composition and structure. Several types of comparisons were made: (1) comparisons of left and right banks at transects (all sampling dates), and (2) comparisons among transects along each bank (spring 1980 and summer/fall 1980). Spearman's rho was used to determine if differences in community structure were significant (summer/fall 1980).

C.5-6. Results

- Comparisons of community structure using Kendall's coefficient of concordance showed:

  -- Macroinvertebrate community structure was dissimilar between opposite banks at Transect 3 (discharge) in summer/fall 1979 and spring 1980, but was similar in summer/fall 1980 (Table C.5-5).

  -- Macroinvertebrate community structure was similar between opposite banks at Transect 4 in summer/fall 1979, but the pattern was not consistent in summer/fall 1980 (similar in September, dissimilar in October)(Table C.5-5).

  -- Macroinvertebrate community structure was similar between opposite banks at Transect 5 (summer/fall 1980) and inconsistent between banks at Transect 6 (dissimilar in September 1980 and similar in October 1980)(Table C.5-5).

  -- Macroinvertebrate community structure along the right bank among Transects 1, 3, and 6 (discharge and controls) and among Transects 3, 4, and 5 (affected zone) were similar in spring 1980 (Table C.5-6).

  -- Macroinvertebrate community structure in summer/fall 1980 at all stations along the right bank were similar with the exception of a small degree of dissimilarity between stations 3R and 6R, and 4R and 6R in October 1980 (Table C.5-6, C.5-7).

  -- Macroinvertebrate community structure patterns in summer/fall 1980 at all stations along the left bank were not always consistent; stations 3L-4L and 4L-5L were consistently similar, 3L-6L and 4L-6L were consistently dissimilar, 3L-5L were dissimilar in September and similar in October, and 5L-6L were similar in September and dissimilar in October (Table C.5-6, C.5-7).

- Due to an unannounced maintenance shutdown (June to mid-October 1979) of R.P. Smith Unit 4 (90 MWe) representing a 70% loss of the power station's rated capacity, differences in water temperature were highly variable during the summer/fall 1979 study period. Increases in water temperature ranging from 0 to 8C were observed in the discharge area (Transect 3) from late July to September, while

ΔTs > 0 were essentially non-existent downstream in this period. During October and November, plant capacity returned to normal levels and increases in water temperature were seen at all plume stations. Plant capacity was normal during the spring 1980 and summer/fall 1980 studies.

- Total and species-specific densities (number of organisms/m^2) were determined for each station in each sampling period (Tables C.5-8 through C.5-11).

- Macroinvertebrate stations in summer/fall 1979 were not consistently on similar substrates (i.e., Transect 2 consistently sand, other transects generally pebble). All subsequent studies located stations on pebble substrates.

- Total macroinvertebrate density in summer/fall 1979 showed no significant effects of season, date within season, transect, bank, or interaction terms whereas Duncan's Multiple Range Test showed seasons were significantly different (Table C.5-12).

- Total macroinvertebrate biomass in summer/fall 1979 showed a significant effect due to transect and transect/season interaction but not due to season, date within season, bank, or other interaction terms (Table C.5-13).

- Total macroinvertebrate density and biomass showed no station effects in spring 1980 (Table C.5-13).

- No species-specific analyses were completed for the summer/fall 1979 study due to a high incidence of zero catches.

- *Ferrissia* sp. density station differences were inconsistent in summer/fall 1980. Station location effect was significant in October 1980 ($p = 0.007$) but not in September 1980 ($p = 0.66$). In October, abundances at stations 3R and 5L were significantly greater than at 3L, 5R, 6L, and 6R (Table C.5-14). There were no biomass differences due to station location.

- There were no differences in *Stenonema* sp. abundance or biomass due to station location in spring 1980 and summer/fall 1980 ($p > 0.05$).

- Differences in *Potamanthus* sp. abundance and biomass due to station location were inconsistent. In spring 1980, there were significant station effects on both density and biomass with density and biomass at 3R significantly greater than 1L, 3L, 4L, 5L, 6L, and 5R (Table C.5-15). There were no differences due to station location in summer/fall 1980 ($p > 0.05$).

- There were no differences in _Hydropsyche_ sp. abundance or biomass due to station location in spring 1980 ($p > 0.05$).

- Differences in _Cheumatopsyche_ sp. abundance and biomass due to station location were inconsistent. In spring 1980, station location significantly affected both density and biomass ($p= 0.001$ in both cases), but these differences were primarily due to zero catches at stations 1L, 4R, and 5L (Table C.5-16). There were no station location effects on the abundance or biomass of this species in summer/fall 1980 ($p < 0.05$).

- _Tanytarsus_ sp. abundance and biomass consistently showed significant station effects in spring 1980 ($p=0.04$) and summer/fall 1980 ($p = 0.008$ and 0.004 for September and October, respectively). In spring 1980, densities at stations 1L, 4R, and 6L were significantly greater than at 4L, 5L, and 6R (Table C.5-17). In summer/fall 1980, density and biomass at station 5R were consistently less than at all other stations (Tables C.5-18, C.5-19).

- _Caenis_ sp. density and biomass was significantly affected by station location in summer/fall 1980 ($p = 0.0009$), but these differences were not related to the discharge plume (Table C.5-20).

- _Dicrotendipes_ sp. density was affected by station location in summer/fall 1980 ($p = 0.048$ for September and October) but the effect was not consistent (i.e., in September 1980, Station 4L was significantly less than all other stations; in October 1980, Station 4L > all other stations). For October 1980, all heated stations had consistently lower densities than unheated stations (Table C.5-21). _Dicrotendipes_ sp. biomass was significantly affected by station location in September 1980 ($p = 0.0001$), but not in October 1980 ($p = 0.32$). In September 1980, biomass at Stations 4L and 4R was significantly less than at all other stations (Table C.5-22).

- Thus, significant station differences are apparently due to other physical phenomena (e.g., depth, current) or natural population variability but not to the heated discharge.

Table C.5-1. Macroinvertebrate target species for R.P. Smith studies.

Summer/Fall 1979	Spring 1980	Summer/Fall 1980
Ferrissia sp.	Stenonema sp.	Ferrissia sp.
Tanytarsus sp.	Potamanthus sp.	Caenis sp.
Stenonema sp.	Hydropsyche sp.	Potamanthus sp.
Potamanthus sp.	Cheumatopsyche sp.	Tanytarous sp.
	Tanytarsus sp.	Dicrotendipes sp.
		Polypedilum sp.
		Ablabesmyia sp.
		Cheumatopsyche sp.
		Cricotopus sp.

Table C.5-2. Cross-classified nested analysis of variance model used to analyze total density and biomass in summer/fall 1979.

$$Y_{ijklm} = U + S_i + D_{ij} + X_k + (XS)_{ik} + (XD)_{ijk} + Y_l + (YS)_{il} + (YD)_{ijl} + (XY)_{kl} + (XYS)_{ikl} + (XYD)_{ijkl} + E_{ijklm}$$

where

$i = 1, 2$	denoting the 2 seasons (summer and fall)
$j = 1, 2, 3$	denoting the days in season
$k = 1, 5$	denoting the 5 transects
$l = 1, 2$	denoting the left or right banks
$m = 1, 2$	denoting the number of replicates

Y_{ijklm}	represents $\log_e$ (CPUE+1) of the m^{th} replicate of the l^{th} position at the k^{th} transect on the j^{th} day of the i^{th} season
U	is a parameter representing overall average $\log_e$ (CPUE+1)
S_i	represents the effect of the i^{th} season
D_{ij}	represents the effect due to sampling on the j^{th} day in the i^{th} season
X_k	represents the effect of the k^{th} transect
$(XS)_{ik}$	represents the joint effect of the i^{th} season and the k^{th} transect above and beyond the overall effect of each separately
$(XD)_{ijk}$	represents the effect due to sampling on the j^{th} day of the i^{th} season at transect k
Y_l	represents the effect of the l^{th} position in the river
$(YS)_{il}$	represents the joint effect of the i^{th} season and the l^{th} position above and beyond the overall effect of each separately
$(YD)_{ijl}$	represents the effect due to sampling on the j^{th} day of the i^{th} season at position l
$(XY)_{kl}$	represents the joint effect of transect k and position l above and beyond the overall effect of each separately
$(XYS)_{ikl}$	represents the joint effect of season i, transect k and position l, over and beyond the overall effect of each separately
$(XYD)_{ijkl}$	represents the effect due to sampling on the j^{th} day of the i^{th} season at transect k and position l
E_{ijklm}	represents the experimental error assumed to be normally and undependently distributed with a mean of zero and a variance of σ^2.

Table C.5-3. Cross-classified nested analysis of variance model for target species evaluation in summer/fall 1979.

Source	Degrees of Freedom	Expected Mean Squares
Mean (U)	1	
Month (M)	1	$\sigma^2 + 10\sigma^2_M$
Station (S)	4	$\sigma^2 + 2\sigma^2_{MS} + 4\ _S$
MXS	4	$\sigma^2 + 2\sigma^2_{MS}$
Residual	10	σ^2
Total	20	

Table C.5-4. One way analysis of variance model used in spring and summer/fall 1980.

$$Y_{ij} = U + S_i + E_{ij}$$

where

$i = 1, 2, \ldots, 8$	denoting the 8 sampling stations
$j = 1, 2, 3$	denoting the 3 replicates per station
Y_{ij}	represents $\log_e$ (CPUE + 1) of replicate j at station i
U	is a parameter representing the overall average $\log_e$ (CPUE + 1)
S_i	represents the effect due to station i where each station is an individual transect-bank combination
E_{ij}	represents the experimental error assumed to be normally and independently distributed with a mean of zero and a variance of σ^2.

Source	Degrees of Freedom	Expected Mean Square
Mean (U)	1	
Station (S)	9	$\sigma^2 + 2\phi_s$
Error (E)	10	σ^2
Total	20	

ϕ = fixed effect

σ^2 = variance component

Table C.5-5. Cross-stream community structure comparisons with Kendall coefficient of concordance (from Refs. 2-4)(PROB >0.05 indicates dissimilarity).

Summer/fall 1979:

Transect	W	F	DF1	DF2	PROB
3	0.577373	1.36615	49	49	0.139126
4	0.765840	3.27058	55	55	0.000011

Spring 1980:

Transect	W	F	DF1	DF2	PROB
3	0.520079	1.08367	50	50	0.388722

Summer/fall 1980:

September 1980:

Transect	W	F	DF1	DF2	PROB
3	0.693577	2.26347	36	36	0.0082
4	0.712456	2.47773	36	36	0.0039
5	0.742355	2.88130	42	42	0.0004
6	0.531239	1.13328	39	39	0.3490

October 1980:

Transect	W	F	DF1	DF2	PROB
3	0.719636	2.56679	42	42	0.0014
4	0.587164	1.42227	36	36	0.1476
5	0.646814	1.83137	44	44	0.0238
6	0.658265	1.92624	44	44	0.0160

Table C.5-6. Community composition comparisons among stations along one bank using Kendall's coefficient of concordance (from Refs. 2 - 4).

Spring 1980:

Bank	Transect	W	F	DF1	DF2	PROB
MD	3, 4, 5	0.687603	4.40212	69	138	9.08162E-14
MD	1, 3, 6	0.572131	2.67433	69	138	4.98088E-07

Summer/Fall 1980 (all transects)

September 1980:

Bank	W	F	DF1	DF2	PROB
West Virginia	0.500944	3.01135	56	168	0.0000
Maryland	0.681545	6.42048	49	147	0.0000

October 1980:

Bank	W	F	DF1	DF2	PROB
West Virginia	0.415977	2.13678	64	192	0.0000
Maryland	0.559767	3.81457	55	165	0.0000

Table C.5-7. Pairwise community composition comparisons between stations along the same bank in summer/fall 1980 using Spearman's correlation coefficient (from Ref. 4).

September 1980:

W. Virginia

	TRANST3	TRANST4	TRANST5	TRANST6
TRANST3	1.00000 0.0000	0.76153 0.0001	0.17086 0.1997	0.10770 0.4210
TRANST4	0.76153 0.0001	1.00000 0.0000	0.33200 0.0109	0.15695 0.2394
TRANST5	0.17086 0.1997	0.33200 0.0109	1.00000 0.0000	0.48693 0.0001
TRANST6	0.10770 0.4210	0.15695 0.2394	0.48693 0.0001	1.00000 0.0000

Maryland

	TRANST3	TRANST4	TRANST5	TRANST6
TRANST3	1.00000 0.0000	0.68367 0.0001	0.59560 0.0001	0.47676 0.0004
TRANST4	0.68367 0.0001	1.00000 0.0000	0.62203 0.0001	0.47471 0.0004
TRANST5	0.59560 0.0001	0.62203 0.0001	1.00000 0.0000	0.59703 0.0001
TRANST6	0.47676 0.0004	0.47471 0.0004	0.59703 0.0001	1.00000 0.0000

October 1980:

W. Virginia

	TRANST3	TRANST4	TRANST5	TRANST6
TRANST3	1.00000 0.0000	0.63058 0.0001	0.25160 0.0416	-0.11498 0.3579
TRANST4	0.63058 0.0001	1.00000 0.0000	0.57438 0.0001	-0.06011 0.6316
TRANST5	0.25160 0.0416	0.57438 0.0001	1.00000 0.0000	0.06961 0.5786
TRANST6	-0.11498 0.3579	-0.06011 0.6316	0.06961 0.5786	1.00000 0.0000

Maryland

	TRANST3	TRANST4	TRANST5	TRANST6
TRANST3	1.00000 0.0000	0.70728 0.0001	0.44482 0.0005	0.22605 0.0909
TRANST4	0.70728 0.0001	1.00000 0.0000	0.38976 0.0027	0.21581 0.1069
TRANST5	0.44482 0.0005	0.38976 0.0027	1.00000 0.0000	0.49397 0.0001
TRANST6	0.22605 0.0909	0.21581 0.1069	0.49397 0.0001	1.00000 0.0000

Table C.5-8. Density (no./m^2) of selected macroinvertebrate taxa from natural substrates, summer/fall 1979 (from Ref. 2).

		July Transect			August Transect					September Transect					October Transect					November Transect				
Taxa	Location	2	3	5	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
Ferrissia sp.	Left Bank	21	26	3	18	53	221	0	35	9	171	88	0	12	27	132	74	0	18	0	29	56	0	0
	Right Bank	9	68	0	0	259	315	144	6	0	15	109	32	0	0	44	568	47	9	0	24	68	0	0
Stenonema sp.	Left Bank	24	18	118	3	62	156	0	0	0	44	135	6	0	29	74	129	29	44	66	29	112	27	0
	Right Bank	3	76	6	0	6	103	88	0	0	15	47	21	0	9	18	147	18	3	50	9	174	6	0
Hexagenia sp.	Left Bank	26	0	0	226	0	0	14	12	156	0	0	0	27	191	3	0	3	53	35	0	0	0	0
	Right Bank	12	0	9	9	0	0	6	65	26	0	0	0	21	24	0	0	0	3	12	0	0	0	12
Tanytarsus sp.	Left Bank	47	38	109	9	1,232	262	18	18	0	26	0	0	3	3	21	6	3	0	3	3	9	3	0
	Right Bank	0	276	9	38	94	59	6	3	0	35	0	85	0	0	0	59	12	0	0	0	71	15	0
Total Density	Left Bank	459	621	944	1,962	2,568	2,056	2,174	835	482	935	662	315	447	700	638	782	197	368	409	250	665	494	312
	Right Bank	715	1,297	379	1,191	2,382	1,209	888	2,068	358	432	562	697	191	103	444	1,291	429	218	297	518	835	62	244
No. Taxa	Left Bank	35	21	40	36	43	33	29	34	22	35	25	17	25	32	30	23	20	20	29	22	34	23	16
	Right Bank	29	35	21	24	34	37	31	24	17	28	34	40	13	15	24	40	26	15	15	24	36	13	13
Total		45	40	49	42	53	44	43	43	27	45	41	46	30	35	42	42	35	26	30	33	46	27	20
Diversity	Left Bank	4.18	2.76	3.84	3.20	3.15	3.75	2.00	3.81	2.83	4.02	3.71	2.31	2.94	3.33	3.81	3.79	2.41	3.10	3.58	3.10	3.77	2.28	2.85
	Right Bank	3.00	4.06	2.95	3.18	3.44	3.80	3.83	2.64	2.76	3.64	3.95	4.34	2.10	2.85	3.38	3.30	3.14	2.29	2.69	3.51	3.95	2.87	1.88
Evenness	Left Bank	0.9	0.74	0.79	0.70	0.63	0.77	0.46	0.84	0.73	0.84	0.86	0.69	0.72	0.77	0.84	0.88	0.73	0.81	0.85	0.84	0.82	0.56	0.81
	Right Bank	0.7	0.83	0.77	0.74	0.72	0.79	0.84	0.64	0.75	0.86	0.86	0.89	0.73	0.90	0.83	0.67	0.75	0.70	0.81	0.84	0.82	0.96	0.59
Substrate Type[1/]	Left Bank	5	4	5	5	4	4	5	3	4	4	4	5	3	4	4	4	5	1	4	2	4	5	8
	Right Bank	5	4	4	5	4	4	4	5	8	4	4	4	5	5	3	3	3	5	6	4	3	1	5
Temperature	Left Bank	27	27.5	27.5	22.2	24.0	23.0	22.8	22.0	20.0	20.0	20.5	20.2	18.5	11.0	12.0	13.0	14.5	16.1	8.6	8.0	7.9	8.1	8.0
	Right Bank	27	26.0	27.5	22.3	23.3	25.4	24.1	22.0	21.5	21.0	22.0	19.9	17.6	11.0	15.2	15.2	15.0	17.1	8.7	11.8	9.3	9.0	8.0

1/1 = solid rock; 2 - boulder, >256 mm; 3 = gravel, 64 to 256 mm; 4 = pebble, 2 to 64 mm; 5 = sand, 0.06 to 2.0 mm; 6 = silt, 0.004 to 0.06 mm; 8 = detritus.

Table C.5-9. Density (no./m^2) and biomass (mg/m^2) of selected benthic macroinvertebrate taxa collected with a dome suction sampler, spring 1980 (from Ref. 3).

Taxon	Parameter	Transect 1 Left[1]	Transect 1 Right[2]	Transect 3 Left	Transect 3 Right	Transect 4 Left	Transect 4 Right	Transect 5 Left	Transect 5 Right	Transect 6 Left	Transect 6 Right
Mayflies											
<u>Stenonema</u> sp.											
	Density	6	18	0	24	12	3	15	6	3	14
	Biomass	5	44	0	38	6	Tr[3]1	9	2	2	15
<u>Potamanthus</u> sp.											
	Density	26	150	35	400	15	167	26	32	3	79
	Biomass	13	91	9	209	Tr	65	10	3	4	69
Caddisflies											
<u>Hydropsyche</u> sp.											
	Density	0	15	0	6	3	6	15	3	15	12
	Biomass	0	35	0	Tr	9	15	10	1	7	25
<u>Cheumatopsyche</u> sp.											
	Density	0	35	3	9	9	0	0	3	9	18
	Biomass	0	32	Tr	8	9	0	0	Tr	4	5
Midge											
<u>Tanytarsus</u> sp.											
	Density	26	12	3	24	0	29	0	6	18	0
	Biomass	6	12	6	2	0	Tr	0	2	1	0
Total	Density	556	747	288	885	238	685	203	156	391	285
	Biomass	148	468	75	364	135	85	55	91	74	193
Total Number Taxa		23	39	30	41	24	24	18	24	15	20
Temperature °C		16.0	16.5	18.0	22.6	18.0	21.5	18.0	18.9	17.5	17.7

[1]West Virginia Shore
[2]Maryland Shore
[3] < 0.5 mg/m^2

Table C.5-10. Density (no./m^2) and biomass (mg/m^2) of selected benthic macroinvertebrate taxa summer/fall 1980 (September) (from Ref. 4).

Taxon	Parameter	3L	3R	4L	4R	5L	5R	6L	6R
		Station							
Snails									
Ferrissia sp.	Density	125	220	345	220	502	220	157	291
	Biomass	20	58	9	4	143	Tr*	38	7
Mayflies									
Caenis sp.	Density	78	722	16	753	549	1,286	71	453
	Biomass	13	75	Tr	63	75	147	45	40
Potamanthus sp.	Density	753	1,318	596	220	47	141	141	105
	Biomass	197	270	78	70	53	80	121	63
Midges									
Tanytarsus sp.	Density	533	1,255	549	643	471	69	157	262
	Biomass	39	73	6	4	7	Tr	5	2
Dicrotendipes sp.	Density	0	1,286	125	424	2,102	922	620	780
	Biomass	0	144	Tr	6	134	115	50	47
Polypedilum sp.	Density	706	1,631	1,302	1,051	63	135	157	17
	Biomass	66	115	25	42	5	16	Tr	1
Ablabesmyia sp.	Density	63	125	282	141	141	304	149	141
	Biomass	32	56	Tr	2	12	35	11	13
Total	Density	8,094	10,763	15,780	7,831	6,375	5,133	4,388	3,366
	Biomass	1,401	1,061	467	557	676	603	858	523
Total No. taxa		27	32	27	34	39	28	31	27
Temperature (°C)		26.2	32.7	26.2	33.0	27.2	28.7	28.0	27.0

*Tr = less than 0.5 mg/m^2.

Table C.5-11. Density (no./m^2) and biomass (mg/m^2) of selected benthic macroinvertebrate taxa summer/fall 1980 (October) (from Ref. 4).

Taxon	Parameter	Station 3L	3R	4L	4R	5L	5R	6L	6R
Snails									
Ferrissia sp.	Density	173	1,631	957	397	1,192	355	157	227
	Biomass	30	132	132	21	439	557	109	28
Mayflies									
Stenonema sp.	Density	157	267	361	173	753	94	0	47
	Biomass	22	54	60	34	184	1,898	0	42
Caddisflies									
Cheumatopsyche sp.	Density	376	74	1,020	26	63	0	0	0
	Biomass	102	60	435	32	15	0	0	0
Midges									
Cricotopus sp.	Density	627	212	329	154	0	16	0	78
	Biomass	44	24	34	12	0	Tr*	0	5
Tanytarsus sp.	Density	1,302	180	160	44	94	16	55	682
	Biomass	19	24	11	5	Tr	Tr	1	18
Dicrotendipes sp.	Density	722	78	1,349	110	1,004	580	463	604
	Biomass	27	7	53	14	30	37	14	23
Polypedilum sp.	Density	722	94	502	31	31	0	635	63
	Biomass	15	9	51	2	Tr	0	6	Tr
Total	Density	6,169	4,796	11,498	2,128	5,304	2,245	4,216	4,568
	Biomass	483	665	1,629	479	1,090	2,639	658	714
Total No. taxa		31	36	32	30	35	31	38	32
Temperature (°C)		13.5	25.0	14.0	24.5	15.5	17.5	15.0	14.2

*Tr = less than 0.5 mg/m^2.

Table C.5-12. ANOVA results for total macroinvertebrate density - summer/fall 1979 (from Ref. 2).

SOURCE	DF	TYPE IV	F VALUE	PR>F
SEASON	1	14.6465	4.22	0.1324
DAY (SEASON)	3	10.4229		
TRANSECT	4	7.8622	1.50	0.2731
SEASON X TRANSECT	4	3.8523	0.74	0.5876
TRANSECT X DAY (SEASON)	10	13.0684		
POSITION	1	0.9487	3.67	0.1514
SEASON X POSITION	1	0.2051	0.79	0.4389
POSITION X DAY (SEASON)	3	0.7764		
TRANSECT X POSITION	4	3.2349	0.74	0.5871
SEASON X TRANSECT X POSITION	4	2.0430	0.47	0.7597
TRANSECT X POSITION X DAY (SEASON)	10	10.9606		
ERROR	46	6.7655		
TOTAL	91	74.7865		

GROUPING	MEAN	N	SEASON	Y
A	6.742129	26	1	1
A	6.602515	26	1	3
B	6.037640	20	2	1
B	5.752027	20	2	3

Table C.5-13. ANOVA results for total macroinvertebrate biomass - summer/fall 1979 (from Ref. 2).

	DF	TYPE IV	F VALUE	PR>F
SEASON	1	7.3810	4.95	0.1126
DAY (SEASON)	3	4.4757		
TRANSECT	4	15.0718	13.68	0.0005
SEASON X TRANSECT	4	4.4377	4.03	0.0337
TRANSECT X DAY (SEASON)	10	2.7543		
POSITION	1	0.1340	0.55	0.5123
SEASON X POSITION	1	0.4381	1.80	0.2726
POSITION X DAY (SEASON)	3	0.7316		
TRANSECT X POSITION	4	4.7835	0.71	0.6054
SEASON X TRANSECT X POSITION	4	2.4216	0.36	0.8331
TRANSECT X POSITION X DAY (SEASON)	10	16.9232		
ERROR	46	13.1261		
TOTAL	91	72.6786		

NOTE: Stations are numbered as follows for Spring 1980

Transect	Bank	Station Number
1	Left	1
	Right	2
3	Left	3
	Right	4
4	Left	5
	Right	6
5	Left	7
	Right	8
6	Left	9
	Right	10

NOTE: Stations are numbered as follows for Summer/Fall 1980

Transect	Bank	Station Number
3	Left (W.Va.)	1
	Right (Md.)	2
4	Left (W.Va.)	3
	Right (Md.)	4
5	Left (W.Va.)	5
	Right (Md.)	6
6	Left (W.Va.)	7
	Right (Md.)	8

Table C.5-14. Duncan's Multiple Range Test for density of Ferrissia sp. in October 1980 (from Ref. 4).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=0.499244

GROUPING		MEAN	N	STATION
	A	7.157306	3	2
	A			
	A	7.082050	3	5
	A			
B	A	6.390025	3	3
B	A			
B	A	5.872121	3	4
B				
B		5.430114	3	8
B				
B		5.378074	3	6
B				
B		5.087727	3	1
B				
B		5.052376	3	7

Table C.5-15. Duncan's multiple range test for (a) density and (b) biomass of <u>Potamanthus</u> sp. in spring 1980 (from Ref. 3).

(a)
```
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

          ALPHA LEVEL=.05        DF=10         MS=0.509646

          GROUPING                       MEAN        N     STATION

                   A                 5.953528        2        4
                   A
          B        A                 5.126437        2        6
          B        A
          B        A                 5.012515        2        2
          B        A
          B        A      C          4.353260        2        10
          B               C
          B        D      C          3.536149        2        3
          B        D      C
          B        D      C          3.399057        2        8
                   D      C
                   D      C          3.144273        2        1
                   D      C
                   D      C          3.144273        2        7
                   D
                   D                 2.564416        2        5

                   E                 0.964480        2        9
```

(b)
```
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

          ALPHA LEVEL=.05        DF=8          MS=0.255174

          GROUPING                       MEAN        N     STATION

                   A                 5.272971        2        4
                   A
                   A                 4.870697        1        6
                   A
                   A                 4.510813        2        2
                   A
          B        A                 4.228027        2        10
          B
          B        C                 3.021858        1        7
                   C
          D        C                 2.551355        2        1
          D        C
          D        C                 2.244687        2        3
          D
          D                          1.385861        2        9
          D
          D                          1.364638        2        8

                   E                 0.000000        2        5
```

Table C.5-16. Duncan's multiple range test for (a) density and (b) biomass of Cheumatopsyche sp. in spring 1980 (from Ref. 2).

(a) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=0.953967

GROUPING	MEAN	N	STATION
A	3.578346	2	2
B A	2.671895	2	10
B A C	2.237822	2	4
B A C	2.237822	2	5
B A C	1.462844	2	9
B C	0.964480	2	3
B C	0.964480	2	8
C	0.000000	2	1
C	0.000000	2	6
C	0.000000	2	7

(b) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=8 MS=0.366418

GROUPING	MEAN	N	STATION
A	3.503242	2	2
B A	2.237822	2	5
B A	2.178930	2	4
B	1.703187	2	10
B C	1.117845	2	9
C	0.249496	2	8
C	0.000000	2	1
C	0.000000	2	3
C	0.000000	1	6
C	0.000000	1	7

Table C.5-17. Duncan's multiple range test for density of *Tanytarsus* sp. in spring 1980 (from Ref. 3).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=1.09702

GROUPING		MEAN	N	STATION
	A	3.307351	2	1
	A			
	A	3.209555	2	6
	A			
	A	2.873278	2	9
	A			
B	A	2.427324	2	2
B	A			
B	A	1.936213	2	4
B	A			
B	A	1.928960	2	8
B	A			
B	A	0.964480	2	3
B				
B		0.000000	2	5
B				
B		0.000000	2	7
B				
B		0.000000	2	10

Table C.5-18. Duncan's multiple range test for *Tanytarus* sp. density in summer/fall 1980 (from Ref. 4).

(a) September 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.27152

GROUPING	MEAN	N	STATION
A	7.031614	3	2
A	6.356321	3	4
A	6.293676	3	3
A	6.275103	3	1
A	5.839501	3	5
A	5.413617	3	8
A	4.860164	3	7
B	2.722893	3	6

(b) October 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.17333

GROUPING			MEAN	N	STATION
	A		7.081693	3	1
B	A		5.843391	3	8
B	A	C	5.177453	3	2
B		C	4.860164	3	3
B		C	4.461536	3	5
B		C	3.875804	3	7
		C	3.652647	3	4
	D		1.290808	3	6

Table C.5-19. Duncan multiple range test for <u>Tanytarsus</u> sp. biomass in summer/fall 1980 (from Ref. 4).

(a) September 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.27145

GROUPING	MEAN	N	STATION
A	4.285974	3	2
B A	3.435754	3	1
B C	1.631316	3	7
C	1.183464	3	3
C	1.018555	3	5
C	0.883861	3	4
C	0.649755	3	8
C	0.000000	3	6

(b) October 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=0.945722

GROUPING	MEAN	N	STATION
A	3.001533	3	1
A	2.611514	3	8
A	2.523036	3	2
B A	1.892902	3	3
B A C	1.733175	3	4
B C	0.503531	3	7
C	0.019053	3	5
C	0.000000	3	6

Table C.5-20. Duncan's multiple range test for *Caenis* sp. (a) density and (b) biomass for summer/fall 1980 (from Ref. 4).

(a) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.87024

GROUPING		MEAN	N	STATION
	A	7.107165	3	6
	A			
B	A	6.500737	3	2
B	A			
B	A	6.412690	3	4
B	A			
B	A	6.017183	3	8
B	A			
B	A	5.973633	3	5
B				
B	C	4.232823	3	7
	C			
D	C	3.038472	3	1
D				
D		1.290808	3	3

(b) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=2.65808

GROUPING			MEAN	N	STATION
	A		4.965215	3	6
	A				
B	A		4.297060	3	2
B	A				
B	A		3.487871	3	8
B	A				
B	A		3.276569	3	7
B	A				
B	A	C	2.930728	3	5
B	A	C			
B	A	C	2.755902	3	4
B		C			
B		C	1.234009	3	1
		C			
		C	0.000000	3	3

Table C.5-21. Duncan's multiple range test for Dicrotendipes sp. density in summer/fall 1980 (from Ref. 4).

September 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.
ALPHA LEVEL=.05 DF=14 MS=1.62307

GROUPING	MEAN	N	STATION
A	7.565915	3	5
A	6.940956	3	2
A	6.628653	3	8
A	6.565882	3	6
A	6.422582	3	7
A	6.046860	3	4
B	3.495327	3	3

October 1980

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.
ALPHA LEVEL=.05 DF=16 MS=3.43204

GROUPING	MEAN	N	STATION
A	7.057105	3	3
A	6.836493	3	5
B A	6.463847	3	1
B A	6.362655	3	8
B A	6.133763	3	7
B A C	4.668051	3	4
B C	3.170728	3	2
C	2.487630	3	6

Table C.5-22. Duncan's multiple range test for Dicrotendipes sp. biomass in September 1980 (from Ref. 4).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=14 MS=0.20633

GROUPING		MEAN	N	STATION
	A	4.904388	3	2
	A			
	A	4.797683	3	5
	A			
B	A	4.574277	3	6
B				
B		3.898513	3	7
B				
B		3.778863	3	8
	C	1.995191	3	4
	D	0.000000	3	3

Table C.5-23. Duncan's multiple range test for Cricotopus sp. (a) density and (b) biomass for summer/fall 1980 (from Ref. 4).

(a) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=12 MS=1.09794

GROUPING	MEAN	N	STATION
A	6.395337	3	1
B A	5.647278	3	3
B A	5.333299	3	2
B A	5.008339	3	4
B	4.142624	3	8
C	1.290808	3	6

(b) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=12 MS=0.828616

GROUPING	MEAN	N	STATION
A	3.742886	3	1
A	3.445137	3	3
B A	2.663590	3	2
B A	2.066257	3	4
B C	1.407941	3	8
C	0.000000	3	6

Table C.5-24. Duncan's multiple range test for Polypedilum sp. density in summer/fall 1980 (from Ref. 4).

September:

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=3.36426

GROUPING			MEAN	N	STATION
	A		7.230498	3	2
	A		6.925183	3	4
	A		6.739233	3	3
B	A		6.440883	3	1
B	A	C	4.559448	3	7
B		C	3.116107	3	6
		C	1.747664	3	5
		C	1.312411	3	8

October:

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=14 MS=3.17264

GROUPING			MEAN	N	STATION
	A		6.582347	3	1
B	A		5.888602	3	7
B	A		5.817494	3	3
B	A	C	4.461536	3	2
B		C	2.581617	3	5
B		C	2.490268	3	4
		C	1.747664	3	8

Table C.5-25. Duncan's multiple range test for *Polypedilum* sp. biomass for summer/fall 1980 (from Ref. 4).

September:

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.48904

GROUPING	MEAN	N	STATION
A	4.734514	3	2
B A	3.724699	3	4
B A	3.557992	3	1
B A C	2.647698	3	3
B D C	2.100262	3	6
D C	0.905287	3	5
D C	0.393788	3	8
D	0.293453	3	7

October:

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=14 MS=0.826775

GROUPING	MEAN	N	STATION
A	3.805567	3	3
B A	2.688806	3	1
B C	1.752840	3	2
B C D	1.424416	3	7
C D	0.840476	3	4
C D	0.128554	3	5
D	0.000000	3	8

Table C.5-26. Duncan's multiple range test for *Ablabesmyia* sp. biomass in summer/fall 1980 (from Ref. 4).

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=16 MS=1.82009

GROUPING			MEAN	N	STATION
	A		4.035364	3	2
B	A		3.386673	3	6
B	A	C	2.570594	3	1
B	A	C	2.433944	3	7
B	A	C	1.951783	3	5
B		C	1.234009	3	8
		C	0.631391	3	4
		C	0.000000	3	3

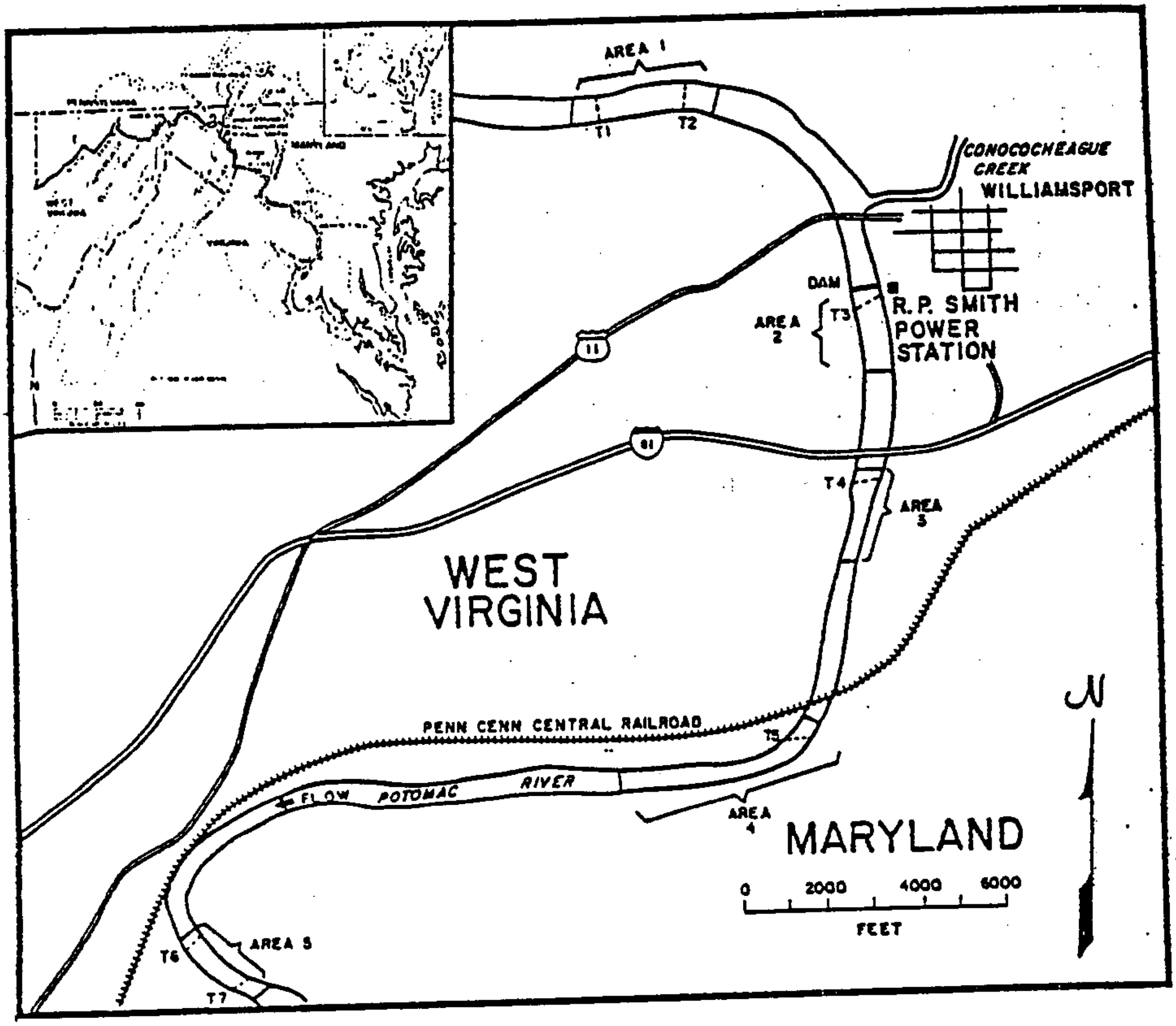

Figure C.5-1. Locations of sampling areas and transects for biological sampling in summer/fall 1979 in the vicinity of the R.P. Smith power station (from Ref. 2).

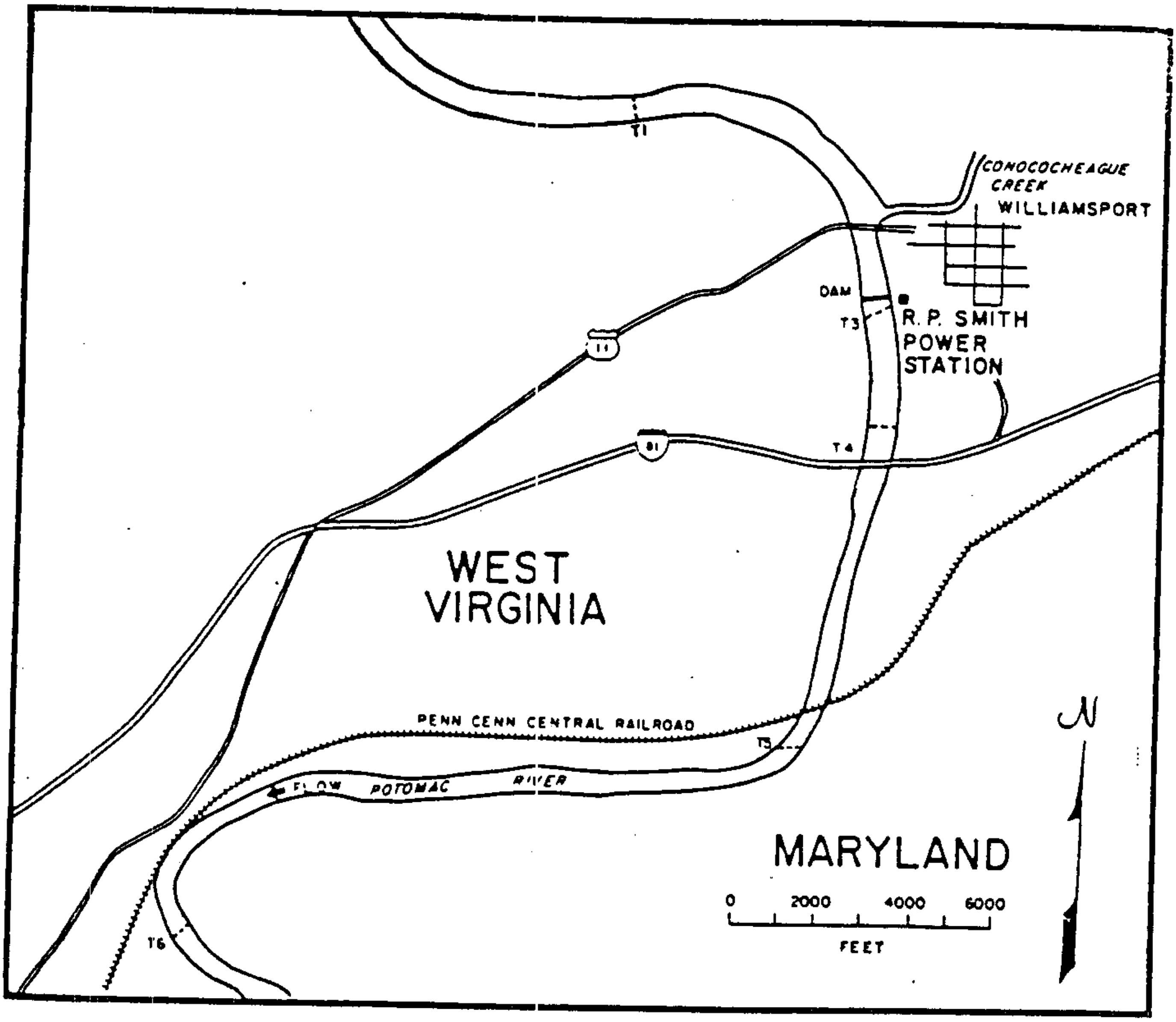

Figure C.5-2. Location of sampling areas and transects for biological sampling in the vicinity of the R.P. Smith power station, spring 1980 (delete T1 for summer/fall 1980 station locations) (from Ref. 3).

APPENDIX C.6. NEARFIELD MACROBENTHIC DRIFT STUDY - FALL 1979

(TI)

C.6-1. Objective

To determine the effect of the R.P. Smith SES on the spatial distributions and composition/abundance of drifting macrobenthic organisms in the Potomac River.

C.6-2. Data Source

Ref. 2.

C.6-3. Study History

This study was the first in a series of drift studies conducted at the R.P. Smith SES. Since subsequent studies utilized somewhat different sampling designs, they are reported individually.

C.6-4. Sampling Methods

Drift sampling was conducted at three transects (Figure C.6-1; Transects T2, T3, and T6) on two non-consecutive nights per month in October and November 1979. Only Transect T3 was within the thermal influence of R.P. Smith operations. At each transect, individual drift samples were collected near the surface at each bank (W. Virginia bank = 1 or L; Maryland bank = 3 or R) and at midstream (2) using 333-μ-mesh drift nets. Temperature and stream flow were measured by flowmeter on each occasion in order to quantify drift. Sampling was initiated on random days approximately 1.5 hours after sunset. Samples were taken for a duration (wet time) of 30 minutes to 1 hour. All collected organisms were preserved in 10% formalin.

C.6-5. Analysis

- All organisms sampled were identified and enumerated. Using abundance and sample volume, total drift densities (no./100 m^3) were calculated for each major group (e.g., mayflies, riffle beetles) and the taxa within each major group. In addition, species diversity and evenness were calculated by station for each sampling date.

- Three species, *Stenonema* spp., *Psychomyia* spp., and *Cheumatopsyche* spp. were selected for additional evaluation. Selection was based on abundance, thermal range, or because the species represented a major taxonomic group (e.g., caddisflies). Due to the low densities observed, species densities could not be compared (ANOVA and Duncan's Multiple Range Test) among stations, transects, or months.

- ANOVA (analysis of variance) was performed to detect significant differences ($\alpha = 0.05$) in total macrobenthic drift density among transects, stations, and months. The model used to analyze drift density is given in Table C.6-1.

- A voided October sample created a missing cell and subsequent imbalance in the analysis model. An estimate (obtained by minimizing the experimental error sum of squares) was used to generate the missing value and the analysis of variance on total drift density was adjusted according to the missing data technique.

- Kendall's coefficient of concordance was employed to determine the similarity of the drifting communities among stations.

C.6-6. Results

- Total macroinvertebrate drift density showed no significant differences among transects or among stations within a transect but was significantly different between days (Table C.6-2).

- Drift abundance estimates across a given river transect were more uniform than mean abundance comparisons among transects. Generally, highest abundances occurred on the Maryland side of the Potomac River (Table C.6-3).

- Highest species diversity and number of taxa occurred at Transect 3, whereas the fewest taxa were collected at Transect 6 (Table C.6-3).

- Community structures were dissimilar between right bank, left bank, and mid-river stations at Transect 3 (Table C.6-4).

- Drift in the October-November period was higher at the immediate discharge area than at any other station (Table C.6-3).

C.6-7. Significance and Critique of Results

- This study does not allow a rigid evaluation of the effect of R.P. Smith operation on drifting macroinvertebrates because:

- *Cricotopus* sp. density and biomass were significantly affected by station location in summer/fall 1980 ($p = 0.001$ and 0.003, respectively). The effect was not related to heated discharge (Table C.5-23).

- Station location significantly affected *Polypedilum* sp. density ($p = 0.003$ and 0.03 in September and October, respectively) and biomass ($p = 0.002$ in both months) in summer/fall 1980. These differences were not consistently related to plant discharge (i.e., September 1980 stations receiving highest heat load had highest densities, but this pattern was not observed in October 1980)(Tables C.5-24 and C.5-25).

- *Ablabesmyia* sp. density in summer/fall 1980 was not affected by station location ($p < 0.05$) but biomass was affected ($p = 0.03$). This effect seems to be related to the very low biomasses observed at the heated and unheated stations at Transect 4 (Table C.5-26).

C.5-7. Significance and Critique of Findings

- Due to sampling inconsistencies (i.e., high variability in type of substrate sampled), ANOVA results for summer/fall 1980 which utilized Transect 2 are suspect. ANCOVA could be used to remove variability due to substrate if particle size data were available (but they are not). ANOVA's comparing stations on Transects 3, 4, 5, and 6 are useful.

- The thermal discharge exhibits no discernible influence on macrobenthic community structure (natural variation in community composition is high along unheated West Virginia shore, whereas all Maryland shore communities are similar).

- While ANOVA's of density and biomass of target species revealed a significant effect due to station location in many cases, they did not reveal any significant differences attributable to the thermal discharge (most apparent differences appear to be shore-to-shore along both heated and unheated transects).

- While many ANOVA-detected station differences may have been due to substrate variability (i.e., summer/fall 1979), ANCOVA, using particle size percentages as a covariant, showed that once stations were located on visually similar substrates, there were no station differences due to substrate variability except for *Potamanthus* sp.

- -- The low level of sampling effort and low catches resulted in low statistical power to detect differences among stations, and

- -- The differences in community structures may be due to the high incidence of single catches within taxa (sampling bias) rather than actual community differences.

- The preliminary results suggest that the operation of the R.P. Smith SES may minimally increase macrobenthic drift in the immediate vicinity of the plant.

Table C.6-1. Analytical model for macrobenthic drift (from Ref. 2).

$$Y_{ijk} = U + D_i + X_j + (XD)_{ij} + Y_k + (YD)_{ik} + (XY)_{jk} + E_{ijk}$$

where

$i = 1, 2, 3, 4$	denoting the 4 sampling days
$j = 1, 2, 3$	denoting the 3 transects
$k = 1, 2, 3$	denoting the 3 positions

Y_{ijk} represents $\log_e$ (CPUE+1) of the k^{th} position at the j^{th} transect on the i^{th} day

U is a parameter representing overall average $\log_e$ (CPUE+1)

D_i represents the effect due to sampling on the i^{th} day

X_j represents the effect of the j^{th} transect

$(XD)_{ij}$ represents the effect due to sampling on the i^{th} day at transect j

Y_k represents the effect of the k^{th} position in the river

$(YD)_{ik}$ represents the effect due to sampling on the i^{th} day at position k

$(XY)_{jk}$ represents the joint effect of the j^{th} transect and the k^{th} position above and beyond the effect of each separately

E_{ijk} represents the experimental error assumed to be normally and independently distributed with a mean of zero and a variance of σ^2.

Source	Degrees of Freedom	Expected Mean Square
Mean (U)	1	
Days (D)	3	$\sigma^2 + 9\sigma^2_D$
Transect (X)	2	$\sigma^2 + 3\sigma^2_{XD} + 12\phi_X$
Transect x Day (XD)	6	$\sigma^2 + 3\sigma^2_{XD}$
Position (Y)	2	$\sigma^2 + 3\sigma^2_{YD} + 12\phi_Y$
Position x Day (YD)	6	$\sigma^2 + 3\sigma^2_{YD}$
Transect x Position (XY)	4	$\sigma^2 + 4\phi_{XY}$
Error	12	σ^2
Total	36	

Table C.6-2. Statistical analysis for total macroinvertebrate density (from Ref. 2).

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	F-VALUE
DAY	3	35.3375	12.17*
TRANSECT	2	16.9024	3.72
TRANSECT X DAY	6	13.6471	2.25
POSITION	2	2.1968	0.72
POSITION X DAY	6	9.1078	1.59
TRANSECT X POSITION	4	3.0592	0.79
ERROR	11	10.6454	
TOTAL	34	90.8962	

*Significant at $\alpha = 0.05$

Table C.6-3. Density (no./100 m^3) of total macroinvertebrate drift, R.P. Smith station, 1979 (from Ref. 2).

	October										November									
	Transect 2			Transect 3			Transect 6				Transect 2			Transect 3			Transect 6			
Parameter	Left	Mid	Right	Left	Mid	Right	Left	Mid	Right	Discharge	Left	Mid	Right	Left	Mid	Right	Left	Mid	Right	Discharge
Total density	39	47	75	47	59	84	12	14	35	111	11	7	21	4	19	35	7	5	0	47
Total taxa																				
Day 1	3	5	9	10	15	16	0	2	5	9	2	1	1	1	5	0	0	1	0	3
Day 2	5	4	7	NS[1]	6	2	3	2	0	12	–	0	0	1	3	2	1	0	0	3
Diversity																				
Day 1	1.58	2.05	3.02	3.18	3.60	3.85	0	1.00	2.32	3.06	1.00	0	0	0	2.25	0	0	0	0	1.58
Day 2	2.06	2.00	2.75	NS	2.52	1.00	1.58	1.00	0	3.43	–	0	0	0	1.25	1.00	0	0	0	1.25
Evenness																				
Day 1	1.00	0.88	0.95	0.96	0.92	0.96	0	1.00	1.00	0.96	1.00	0	0	0	0.97	0	0	0	0	1.00
Day 2	0.89	1.00	0.98	NS	0.98	1.00	1.00	1.00	0	0.96	–	0	0	0	0.79	1.00	0	0	0	0.79
Current speed (m/sec)																				
Day 1	0.4	0.5	0.4	0.8	0.9	0.6	0.7	0.7	0.7	0.3	0.5	0.4	0.4	0.7	0.9	–	0.4	0.5	0.6	0.3
Day 2	0.4	0.3	0.3	NS	0.5	0.6	0.7	0.4	0.6	0.6	–	0.4	0.3	0.8	0.8	0.5	0.4	0.5	0.5	–
Water temperature																				
Day 1	12.0	12.0	12.0	11.0	12.0	13.0	11.0	11.0	11.0	19.0	6.5	7.0	7.0	7.0	7.0	–	6.5	6.5	7.0	20.0
Day 2	13.5	13.6	13.5	NS	14.0	19.0	13.2	13.0	13.3	21.4	–	4.0	4.0	4.0	4.0	10.0	6.5	6.5	6.5	20.0

[1] No sample collected.

Table C.6-4. Community comparison of left and right banks and midstream stations at Transect 3 for macroinvertebrate drift using Kendall's coefficient of concordance (from Ref. 2).

OBS	TAXA	LEFT	MIDDLE	RIGHT	L_RANK	M_RANK	R_RANK
1	NAIS (LPIL)	0.0000	0.0000	5.4348	11.5	5.5	28.5
2	BRANCHIURA SOWERBYI	0.0000	0.0000	4.6296	11.5	5.5	20.0
3	HYDRACARINA (LPIL)	3.3113	3.3445	0.0000	23.0	19.0	7.5
4	GAMMARUS (LPIL)	3.3557	0.0000	4.6296	27.0	5.5	20.0
5	BAETIS (LPIL)	0.0000	0.0000	4.6296	11.5	5.5	20.0
6	PSEUDOCLEON (LPIL)	0.0000	0.0000	4.9505	11.5	5.5	26.5
7	STENONEMA (LPIL)	0.0000	6.0715	13.8889	11.5	25.5	33.5
8	STENACRON (LPIL)	0.0000	9.2593	4.6296	11.5	28.5	20.0
9	HEPTAGENIIDAE (LPIL)	3.3557	15.4321	4.6296	27.0	33.0	20.0
10	TRICORYTHODES (LPIL)	0.0000	3.0864	0.0000	11.5	15.5	7.5
11	CAENIS (LPIL)	0.0000	10.1010	0.0000	11.5	30.0	7.5
12	POTAMANTHUS (LPIL)	3.3557	16.4643	0.0000	27.0	34.0	7.5
13	HEXAGENIA (LPIL)	0.0000	2.9851	4.6296	11.5	11.5	20.0
14	TAENIOPTERYX (LPIL)	3.8314	5.9701	0.0000	31.0	24.0	7.5
15	NEOPERLA (LPIL)	0.0000	5.0505	4.9505	11.5	21.5	26.5
16	PLECOPTERA (LPIL)	6.7114	12.3457	0.0000	32.5	32.0	7.5
17	DUDIRAPHIA (LPIL)	0.0000	0.0000	4.6296	11.5	5.5	20.0
18	SIALIS (LPIL)	0.0000	3.0864	0.0000	11.5	15.5	7.5
19	PSYCHOMYIA (LPIL)	6.7114	11.2233	9.2593	32.5	31.0	31.0
20	HYDROPSYCHE (LPIL)	0.0000	3.0864	0.0000	11.5	15.5	7.5
21	CHEUMATOPSYCHE (LPIL)	10.0671	9.2593	13.8889	34.0	28.5	33.5
22	MACRONEMA (LPIL)	0.0000	3.0864	0.0000	11.5	15.5	7.5
23	HYDROPSYCHIDAE (LPIL)	0.0000	5.0505	4.6296	11.5	21.5	20.0
24	NYCTIOPHYLAX (LPIL)	0.0000	5.0505	0.0000	11.5	21.5	7.5
25	TRICHOPTERA (LPIL)	0.0000	2.9851	0.0000	11.5	11.5	7.5
26	CRICOTOPUS (LPIL)	0.0000	5.0505	9.2593	11.5	21.5	31.0
27	DICROTENDIPES (LPIL)	3.3557	0.0000	0.0000	27.0	5.5	7.5
28	POLYPEDILUM (LPIL)	3.3557	0.0000	5.4348	27.0	5.5	28.5
29	ABLABESMYIA (LPIL)	0.0000	3.0864	9.2593	11.5	15.5	31.0
30	PROCLADIUS (LPIL)	0.0000	0.0000	4.6296	11.5	5.5	20.0
31	CHIRONOMIDAE (LPIL)	3.3557	6.0715	4.6296	27.0	25.5	20.0
32	SIMULIUM (LPIL)	0.0000	6.4309	4.6296	11.5	27.0	20.0
33	SIMULIIDAE (LPIL)	3.3557	0.0000	0.0000	27.0	5.5	7.5
34	PLUMATELLA REPENS	0.0000	3.0864	0.0000	11.5	15.5	7.5

OBS	GROUP	W	F	DF1	DF2	PROB
1	1	0.396619	1.31465	32	64	0.174865

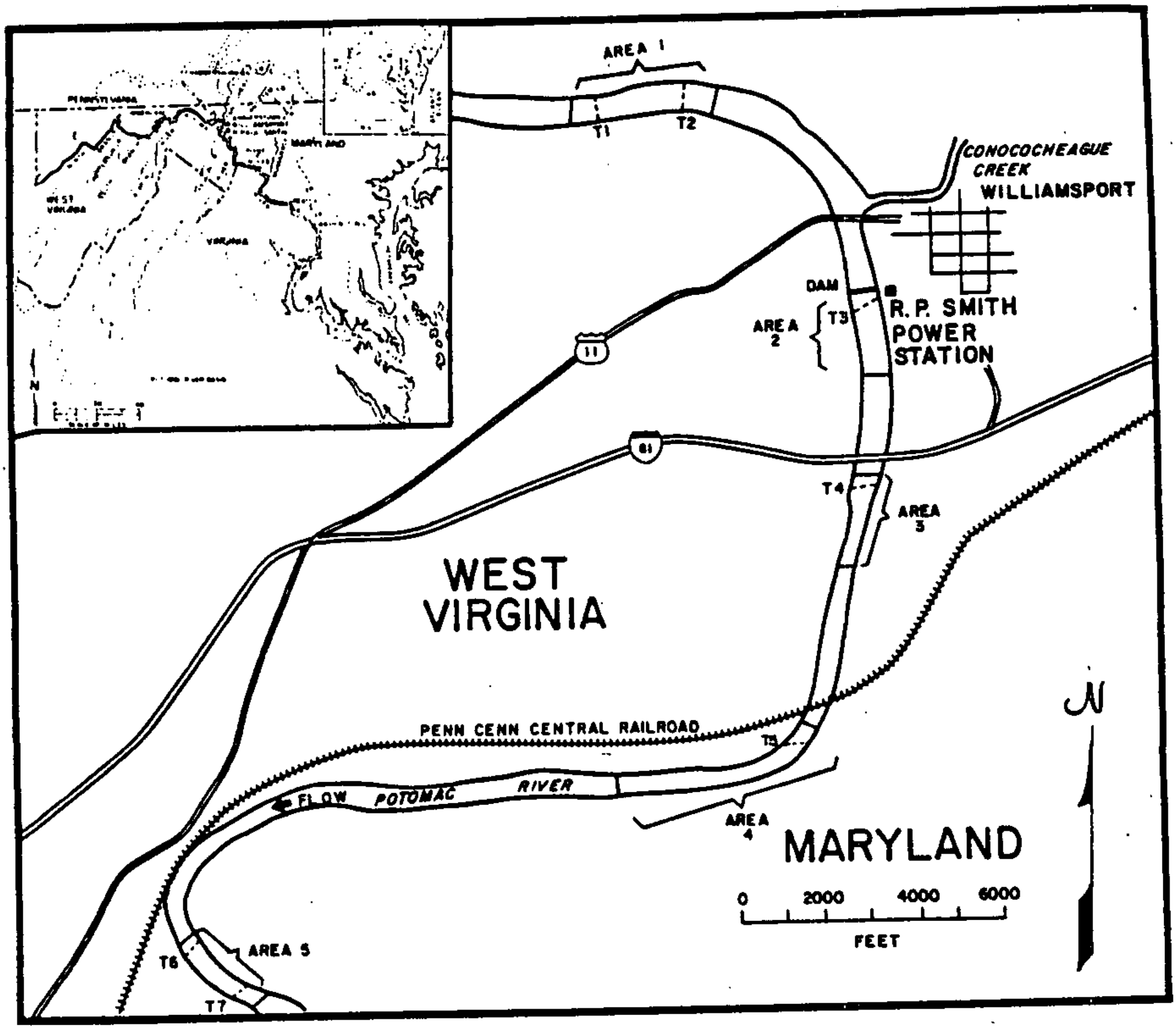

Figure C.6-1. Locations of sampling areas and transects for biological sampling in the vicinity of R.P. Smith power station.

APPENDIX C.7. NEARFIELD MACROBENTHIC DRIFT STUDY - SPRING 1980

(TI)

C.7-1. Objective

To evaluate the effects of the operations of the R.P. Smith SES on the spatial distribution and composition/abundance of drifting macrobenthic organisms in the Potomac River.

C.7-2. Data Source

Ref. 3.

C.7-3. Study History

Macroinvertebrate drift studies were completed at three transects (upstream control - T1, discharge - T3, and downstream control - T6) in October-November 1979. That study did not provide extensive spatial sampling of the region and the sample drift catches were low. October-November generally would be expected to be a low drift period. Sampling was continued the following May (major period of insect emergence) to evaluate drift during a period of potentially extensive emergence and drift.

C.7-4. Sampling Methods

Macroinvertebrate drift samples were collected on two nonconsecutive dates in May at three transects (Figure C.7-1; Transects 1, 3, and 6). Individual surface samples were taken near each shore and at mid-river using 333-μ-mesh drift nets set approximately 1.5 hours after sunset. Sample duration on each date was approximately 2 hours. All organisms collected in drift samples were preserved in 10% formalin. In addition, the physical parameters of current velocity and sample volume (using flowmeters), substrate type, water temperature, air temperature, dissolved oxygen, and sample depth were measured concurrently with each sample.

C.7-5. Analysis

- For each station, all specimens were identified to at least the genus level and enumerated. Using abundance data and sample volume, drift densities (no./100 m^3) were calculated.

- Analyses were completed on the total drift density at all stations and on the individual drifting adult and larval stages of six species (Stenonema spp., Ephemerella spp., Cheumatopsyche spp., Pyschomyia spp., Hydropsyche spp., and Stenelmis spp.) at each station. These species were chosen on the basis of their abundance in previous sampling efforts and their representativeness of major macrobenthic groups of interest (mayflies and caddisflies).

- ANOVA (analysis of variance) was used to determine if significant ($\alpha = 0.05$) differences occurred among stations in the drifting densities of the above six species or in total drift density using the analytical model described in Table C.7-1.

- Kendall's coefficient of concordance was employed to determine if there were significant differences in the species composition among stations.

C.7-6. Results

- All macroinvertebrate drift catches were low (all transect mean densities $\leq$ 30/100 m^3) with high numbers of taxa (25-31) collected at each transect.

- No significant differences in total drift density or in the drift densities of the six target species were found among stations (Table C.7-2).

- The discharge station (Transect 3 - Maryland shore) exhibited the lowest density and fewest number of taxa of all stations, but the total density at Transect 3 was not significantly different from that found at the remaining stations.

- The drift community structure indicated significantly different communities for the right bank, left bank, and mid-river stations at each of the transects (Table C.7-3), at the right bank for all transects (Table C.7-4), at the left bank for all transects (Table C.7-5), and at the mid-river station for all transects (Table C.7-6).

C.7-7. Significance and Critique of Findings

- The high variability among station densities and the resulting low power for detecting 50% differences in abundance (0.23 for total transect density and 0.20 for most abundant species, Psychomyia spp.) limits the use of this analysis for assessing the effects of the R.P. Smith operations on drifting macrobenthic invertebrates.

- Lower drift densities and lower number of taxa recorded at the discharge station (Transect 3 - Maryland) suggests that potential plant effects on drifting macroinvertebrates may occur, but the low sample catches and the resulting low power to detect differences do not allow definitive conclusions.

- Differences in drift community structure among all stations along a transect and among all transect stations along each bank suggest that the drifting fauna at each station may be unique. The fauna may be adapted to the particular environmental conditions characterizing each station.

Table C.7-1. Model for the analysis of macrobenthic drift.

$$Y_{ij} = U + S_i + E_{ij}$$

where:

$i = 1, 2, \ldots, 9$ denoting the 9 sampling stations

$j = 1, 2$ denoting the 2 replicates per station

Y_{ij} represents $\log_e$ (CPUE + 1) of replicate j at station i

U is a parameter representing the overall average $\log_e$ (CPUE + 1)

S_i represents the effect due to station i, where each station is an individual transect - bank combination

E_{ij} represents the experimental error assumed to be normally and independently distributed with a mean of zero and a variance of σ^2.

Source	Degrees of Freedom	Expected Mean Square
Mean (U)	1	
Station (S)	8	$\sigma^2 + 2\,\emptyset_s$
Error (E)	9	σ^2
Total	18	

$\emptyset$ = fixed effect

σ^2 = variance component

Table C.7-2. Analysis of macroinvertebrate drift for total transect density (a); Stenonema spp. (b); Ephemerella spp. (c); Stenelmis spp. (d); Psychomyia spp. (e); Hydropsyche spp. (f); and Cheumatopsyche spp. (g).

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	4.82545255	0.60318157	0.46	0.8590	0.288266	42.8402
ERROR	9	11.91413553	1.32379284		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	16.73958808			1.15056197		2.68570322

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	4.82545255	0.46	0.8590	8	4.82545255	0.46	0.8590

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	4.86831923	0.60853990	1.33	0.3397	0.541092	136.7305
ERROR	9	4.12889507	0.45876612		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	8.99721430			0.67732276		0.49537073

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	4.86831923	1.33	0.3397	8	4.86831923	1.33	0.3397

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	2.82080496	0.35260062	0.42	0.8827	0.271256	164.2400
ERROR	9	7.57824132	0.84202681		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	10.39904628			0.91762019		0.55870681

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	2.82080496	0.42	0.8827	8	2.82080496	0.42	0.8827

Table C.7-2. Continued.

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	3.05029780	0.38128722	0.89	0.5577	0.442687	131.1655
ERROR	9	3.84011601	0.42667956		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	6.89041381			0.65320713		0.49800218

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	3.05029780	0.89	0.5577	8	3.05029780	0.89	0.5577

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	6.56607049	0.82075881	1.03	0.4795	0.477230	82.3462
ERROR	9	7.19264468	0.79918274		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	13.75871517			0.89397021		1.08562425

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	6.56607049	1.03	0.4795	8	6.56607049	1.03	0.4795

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	2.52920362	0.31615045	1.06	0.4611	0.485416	79.6235
ERROR	9	2.68117728	0.29790859		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	5.21038090			0.54581003		0.68548827

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	2.52920362	1.06	0.4611	8	2.52920362	1.06	0.4611

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	1.69122740	0.21140342	0.54	0.8021	0.323756	116.5616
ERROR	9	3.53253825	0.39250425		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	17	5.22376565			0.62650160		0.53748548

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
STATION	8	1.69122740	0.54	0.8021	8	1.69122740	0.54	0.8021